

IN THE CLAIMS

Please amend the claims as follows:

1 (Withdrawn): An insulating film comprising:

a first barrier layer consisting of a material having a first bandgap and a first relative permittivity;

a well layer provided on the first barrier layer, consisting of a material having a second bandgap smaller than first bandgap and having a second relative permittivity larger than first relative permittivity, discrete energy levels being formed in the well layer by a quantum effect; and

a second barrier layer provided on the well layer, consisting of a material having a third bandgap larger than second bandgap and having a third relative permittivity smaller than second relative permittivity.

2 (Withdrawn): The insulating film according to Claim 1, wherein thicknesses of the first and second barrier layers are not smaller than 2.5 angstroms, and

the thickness d_1 of the first barrier layer, the first relative permittivity ϵ_1 , the thickness d_2 of the second barrier layer and the third permittivity ϵ_2 satisfy the condition

$$2.5 > (d_1/\epsilon_1 + d_2/\epsilon_2).$$

3 (Withdrawn): The insulating film according to Claim 2, wherein

the thicknesses of the first and second barrier layers are not smaller than 3.5 angstroms.

4 (Withdrawn): The insulating film according to Claim 1, wherein

a thickness of the well layer is not larger than 5 angstroms.

5 (Withdrawn): The insulating film according to Claim 1, wherein
energy levels of conduction bands of the first and second barrier layers are higher
than an energy level of a conduction band of silicon by 1.0 electron volt or more, and
energy levels of valence bands of the first and second barrier layers are lower
than an energy level of a valence band of silicon by 1.0 electron volt or more.

6 (Withdrawn): An insulating film comprising:
a first barrier layer consisting of a material having a conduction band whose
energy level is higher than an energy level of a conduction band of silicon by 0.5
electron volts or more and having a valence band whose energy level is lower than an
energy level of a valence band of silicon by 0.5 electron volts or more;
a well layer provided on the first barrier layer, the well layer consisting of a
material having a bandgap smaller than a bandgap of SiO₂ and having a relative
permittivity larger than a relative permittivity of SiO₂, and a thickness of the well layer
being not larger than 10 angstroms; and
a second barrier layer provided on the well layer, the second barrier layer
consisting of a material having a conduction band whose energy level is higher than an
energy level of a conduction band of silicon by 0.5 electron volts or more and having a
valence band whose energy level is lower than an energy level of a valence band of silicon
by 0.5 electron volts or more.

7 (Currently Amended): An insulating film comprising:
n (n being an integer larger than 2) layers of barrier layers each consisting of a
material having a bandgap larger than a first bandgap and having a relative permittivity
smaller than a first relative permittivity; and
(n-1) layers of well layers each consisting of a material having a bandgap

smaller than the first bandgap and having a relative permittivity larger than the first relative permittivity, ~~discrete energy levels being formed in the well layer by a quantum effect,~~

each of the barrier layers and each of the well layers being stacked by turns, ~~and~~ discrete energy levels being formed in each of the well layers by a quantum effect,

each of the barrier layers having a thickness not smaller than 2.5 angstroms, and the following condition being satisfied:

$$2.5 > (d_1/\epsilon_1 + d_2/\epsilon_2 + \dots + d_n/\epsilon_n)$$

where d_m ($m=1, 2, \dots, n$) is the thickness of the m -th layer of the barrier layers and ϵ_m ($m=1, 2, \dots, n$) is the relative permittivity of the m -th layer of the barrier layers.

8 (Canceled).

9 (Currently Amended): The insulating film according to Claim[[8]] 7, wherein ~~the thicknesses of the n layers of the barrier layers are~~ each have a thickness not smaller than 3.5 angstroms.

10 (Original): The insulating film according to Claim 7, wherein a thickness of at least one of the well layers is not larger than 5 angstroms.

11 (Currently Amended): An insulating film comprising:

n (n being an integer larger than 2) layers of barrier layers each consisting of a material having a conduction band whose energy level is higher than an energy level of a conduction band of silicon by 0.5 electron volts or more and having a valence band

whose energy level is lower than an energy level a valence band of silicon by 0.5 electron volts or more; and

(n-1) layers of well layers each consisting of a material having a bandgap smaller than a bandgap of SiO₂ and having a relative permittivity larger than a relative permittivity of SiO₂, and thicknesses of the well layers being not larger than 10 angstroms,

each of the barrier layers and each of the well layers being stacked by turns to form a multi-quantum well structure,

each of the barrier layers having a thickness not smaller than 2.5 angstroms, and the following condition being satisfied:

$$2.5 > (d_1/\epsilon_1 + d_2/\epsilon_2 + \dots + d_n/\epsilon_n)$$

where d_m ($m=1, 2, \dots, n$) is the thickness of the m-th layer of the barrier layers and ϵ_m ($m=1, 2, \dots, n$) is the relative permittivity of the m-th layer of the barrier layers.

12 (Withdrawn): An electronic device capable to operate as a capacitor, comprising:
first electrode;

an insulating film provided on the first electrode, including:

n (n being an integer larger than 1) layers of barrier layer consisting of a material having a bandgap larger than a first bandgap and having a relative permittivity smaller than a first relative permittivity; and

(n-1) layers of well layers consisting of a material having a bandgap smaller than the first bandgap and having a relative permittivity larger than the first relative permittivity, discrete energy levels being formed in the well layer by a quantum effect,

each of the barrier layers and each of the well layers being stacked by turns, and discrete energy levels being formed in each of the well layers by a quantum effect;
a second electrode provided on the insulating film.

13 (Currently Amended): An electronic device comprising:

- a semiconductor layer;
- an insulating film provided on the semiconductor layer, including
- n (n being an integer larger than 1) layers of barrier ~~layer~~ layers each consisting of a material having a bandgap larger than a first bandgap and having a relative permittivity smaller than a first relative permittivity; and
- $(n-1)$ layers of well layers each consisting of a material having a bandgap smaller than the first bandgap and having a relative permittivity larger than the first relative permittivity, ~~discrete energy levels being formed in the well layer by a quantum effect,~~
- each of the barrier layers and each of the well layers being stacked by turns, ~~and~~
- discrete energy levels being formed in each of the well layers by a quantum effect, and
- each of the barrier layers having a thickness not smaller than 2.5 angstroms, and
- the following condition being satisfied:
- $2.5 > (d_1/\epsilon_1 + d_2/\epsilon_2 + \dots + d_n/\epsilon_n)$
- where d_m ($m=1, 2, \dots, n$) is the thickness of the m -th layer of the barrier layers
- and ϵ_m ($m=1, 2, \dots, n$) is the relative permittivity of the m -th layer of the barrier layers;
- and
- a gate electrode provided on the insulating film,
- an electric field in the semiconductor layer under the insulating film being controllable, by applying a voltage to gate electrode.

14 (Withdrawn): An electronic device comprising:

- a semiconductor layer containing silicon as a major component; and
- a dielectric film epitaxially grown directly on a major surface of the semiconductor layer, the

dielectric film having a perovskite structure,

an insulating film provided on the semiconductor layer, including:

n (n being an integer larger than 1) layers of barrier layer consisting of a material having a bandgap large than a first bandgap and having a relative permittivity smaller than a first relative permittivity; and

$(n-1)$ layers of well layers consisting of a material having a bandgap smaller than the first relative permittivity, discrete energy levels being formed in the well layer by a quantum effect,

each of the barrier layers and each of the well layers being stacked by turns, and discrete energy levels being formed in each of the well layers by a quantum effect; and

a gate electrode provided on the insulating film,

an electric field in the semiconductor layer under the insulating film being controllable by applying a voltage to the gate electrode.

15 (Withdrawn): An electronic device comprising:

a semiconductor layer containing silicon as a major component; and

a dielectric film epitaxially grown directly on a major surface of the semiconductor layer, the dielectric film having a Ruddlesden-Popper type structure,

a difference between $2^{1/2}$ times lattice constant of the Ruddlesden-Popper type structure along the major plane and a lattice constant of the semiconductor layer along the major plane being not larger than 1.5 %,

Ruddlesden-Popper type structure being expressed by a chemical formula $A_{n+1}B_nO_{3n+1}$, the element A including at least one selected from a group consisting of Ba, Sr, Ca and Mg,

a percentage of Mg content in the element A being not larger than 10%,

the element B including at least one selected from a group consisting of Ti, Zr and Hf,

a percentage of Ti content in the element B being not larger than 80% in a case where $n=1$,
a percentage of Ti content in the element B being not larger than 70% in a case where $n=2$,
a percentage of Ti content in the element B being not larger than 60% in a case where $n=3$, and
a percentage of Ti content in the element B being not larger than 50% in a case where $n \geq 4$.

16 (Withdrawn): An electronic device comprising:
a semiconductor layer containing silicon as a major component; and
a dielectric film epitaxially grown directly on a major surface of the semiconductor layer, the dielectric film having Ruddlesden-Popper type structure,
a difference between $2^{1/2}$ times lattice constant of the Rudlesden-Popper type structure along the major plane and a lattice constant of the semiconductor layer along the major plane being not larger than 1.5%,
the Ruddlesden-Popper type structure having a structure where a layer expressed by a chemical formula A_2B_4 and a layer expressed by a chemical formula A_3B_{207} are stacked by turns,
the element A including at least one selected from a group consisting of Ba, Sr, Ca and Mg,
a percentage of Mg content in the element A being not larger than 10%, and
the element B including at least one selected from a group consisting of Ti, Zr and Hf.

17 (Withdrawn): An electronic device comprising:

a semiconductor layer containing silicon as a major component; and
a dielectric film epitaxially grown directly on a major surface of the semiconductor layer, the dielectric film having an in-phase type structure,
a difference between $2^{1/2}$ times lattice constant of the in-phase type structure along the major plane and a lattice constant of the semiconductor layer along the major plane being not larger than 1.5%,
the in-phase type structure being expressed by a chemical formula $A_{n+2}B_nO_{3n+2}$,
the element A including at least one selected from a group consisting of Ba, Sr, Ca and Mg,
a percentage of Mg content in the element A being not larger than 10%, and
the element B including at least one selected from a group consisting of Ti, Zr and Hf.

18 (Withdrawn): An electronic device comprising:
a semiconductor layer containing silicon as a major component; and
a dielectric film epitaxially grown directly on a major surface of the semiconductor layer, the dielectric film having an in-phase type structure,
a difference between $2^{1/2}$ times lattice constant of the in-phase type structure along the major plane and a lattice constant of the semiconductor layer along the major plane being not larger than 1.5%,
the in-phase type structure having a structure where a layer expressed by a chemical formula $A_3B_2O_8$ and a layer expressed by a chemical formula $A_4B_2O_8$ are stacked by turns,
the element A including at least one selected from a group consisting of Ba, Sr, Ca and Mg,

a percentage of Mg content in the element A being not larger than 10%, and
the element B including at least one selected from a group consisting of Ti, Zr and
Hf.

19 (Withdrawn): An electronic device comprising:
a semiconductor layer containing silicon as a major component; and
a dielectric film epitaxially grown directly on a major surface of the semiconductor
layer, the dielectric film having a well layer,
a difference between $2^{1/2}$ times lattice constant of the dielectric film the major plane
and a lattice constant of the semiconductor layer along the major plane being not larger than
1.5%,
the well layer being expressed by a chemical formula $mAO + nABO_3$ (m being integer
larger than 2, and n being integer larger than zero) where a layer of a sodium chloride structure
expressed by a chemical formula AO and a layer of a perovskite structure expressed by a
chemical formula ABO_3 are stacked,
the element A including at least one selected from a group consisting of Ba, Sr, Ca and
Mg,
a percentage of Mg content in the element A being not larger than 10%, and
the element B including at least one selected from a group consisting of Ti, Zr and Hf.

20 (Withdrawn): An electronic device comprising:
a semiconductor layer containing silicon as a major component; and
a dielectric film epitaxially grown directly on a major surface of the semiconductor
layer, the dielectric film having a well layer,
a difference between $2^{1/2}$ times lattice constant of the dielectric film the major plane and

a lattice constant of the semiconductor layer along the major plane being not larger in 1.5%,

the well layer having a structure where a layer expressed by a chemical formula $m\text{AO} + \text{ABO}_3$ (m being integer larger than zero) and a layer expressed by a chemical formula $n\text{AO} + 2\text{ABO}_3$ (n being integer larger than zero) are stacked by turns, including a layer of a sodium chloride structure expressed by chemical formula AO and a layer of a perovskite structure expressed by a chemical formula ABO_3 ,

the element A including at least one selected from a group consisting of Ba, Sr, Ca and Mg,

a percentage of Mg content in the element A being not larger than 10%, and

the element B including at least one selected from a group consisting of Ti, Zr and Hf.

21 (New): The insulating film according to claim 11, wherein each barrier layer has a thickness not smaller than 3.5 angstroms.

22 (New): The insulating film according to claim 11, wherein at least one of the well layers has a thickness not larger than 5 angstroms.

23 (New): The electronic device according to claim 13, wherein each barrier layer has a thickness not smaller than 3.5 angstroms.

24 (New): The electronic device according to claim 13, wherein at least one of the well layers has a thickness not larger than 5 angstroms.